TITLE:

Unravelling the role of the mandatory use of face covering masks for the control of SARS-CoV-2 in schools: A quasi-experimental study nested in a population-based cohort in Catalonia (Spain)

Authors:

Ermengol Coma[1], Martí Català[2], Leonardo Méndez-Boo[1], Sergio Alonso[3], Eduardo Hermosilla[1,4], Enric Alvarez-Lacalle[3], David Pino[3], Manuel Medina[1], Laia Asso[5], Anna Gatell[6], Quique Bassat[7–11], Ariadna Mas[12], Antoni Soriano-Arandes[*13,14], Francesc Fina[1], Clara Prats[3].

1 Sistemes d'Informació dels Serveis d'Atenció Primària (SISAP), Institut Català de la Salut (ICS), Barcelona, Catalonia (Spain)

2 Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences (NDORMS), University of Oxford, Oxford, UK

3 Department of Physics, Universitat Politècnica de Catalunya, Barcelona, Spain

4 Idiap Jordi Gol, Universitat Autònoma de Barcelona, Barcelona, Spain

5 Secretaria de Salut Pública, Departament de Salut, Generalitat de Catalunya

6 Equip Pediatria Territorial Alt Penedès-Garraf, Barcelona, Catalonia, Spain

7 ISGlobal, Hospital Clínic - Universitat de Barcelona, Barcelona, Spain

8 Centro de Investigação em Saúde de Manhiça (CISM), Maputo, Mozambique

9 ICREA, Pg. Lluís Companys 23, 08010 Barcelona, Spain.

10 Paediatrics Department, Hospital Sant Joan de Déu, Universitat de Barcelona, Esplugues, Barcelona, Spain

11 Consorcio de Investigación Biomédica en Red de Epidemiología y Salud Pública (CIBERESP), Madrid, Spain

12 Direcció assistencial d'Atenció Primària i a la Comunitat, Institut Català de la Salut (ICS), Generalitat de Catalunya, Barcelona, Spain

13 Paediatric Infectious Diseases and Immunodeficiencies Unit, Hospital Universitari Vall d'Hebron, Barcelona, Catalonia (Spain)

14 Vall d'Hebron Research Institute, Barcelona, Catalonia (Spain)

Corresponding author:

Antoni Soriano-Arandes

Passeig Vall d'Hebron, 119-129, 08035 Barcelona, Catalonia (Spain)

Mobile telephone: +34639712438

Email: tsorianoarandes@gmail.com ; asoriano@vhebron.net

Abstract

Background:

Mandatory use of face covering masks (FCM) had been established for children aged six and above in Catalonia (Spain), as one of the non-pharmaceutical interventions aimed at mitigating SARS-CoV-2 transmission within schools. To date, the effectiveness of this mandate has not been well established. The quasi-experimental comparison between 5 year-old children, as a control group, and 6 year-old children, as an interventional group, provides us with the appropriate research conditions for addressing this issue.

Methods:

We performed a retrospective population-based study among 599,314 children aged 3 to 11 years attending preschool (3-5 years, without FCM mandate) and primary education (6-11 years, with FCM mandate) with the aim of calculating the incidence of SARS-CoV-2, secondary attack rates (SAR) and the effective reproductive number (R*) for each grade during the first trimester of the 2021-2022 academic year, and analysing the differences between 5-year-old, without FCM, and 6 year-old children, with FCM.

Findings:

SARS-CoV-2 incidence was significantly lower in preschool than in primary education, and an age-dependent trend was observed. Children aged 3 and 4 showed lower outcomes for all the analysed epidemiological variables, while children aged 11 had the higher values. Six-year-old children showed higher incidence than 5 year-olds (3·54% vs 3·1%; OR: 1·15 [95%CI: 1·08-1·22]) and slightly lower but not statistically significant SAR and R*: SAR were 4·36% in 6 year-old children, and 4·59% in 5 year-old (IRR: 0·96 [95%CI: 0·82-1·11]); and R* was 0·9 and 0·93 (OR: 0·96 [95%CI: 0·87-1·09]), respectively.

Interpretation:

FCM mandates in schools were not associated with lower SARS-CoV-2 incidence or transmission, suggesting that this intervention was not effective. Instead, age-dependency was the most important factor in explaining the transmission risk for children attending school.

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Research in context:

Evidence prior to this study

-Only laboratory or observational studies have been performed to explore the effectiveness of the FCM mandate in the general population.

-To date, there have been no randomised controlled trials on the FCM mandate in schools.

-There is a lack of strong scientific evidence supporting the decision to make FCM mandatory for children over 5 years of age.

-Age-dependency of SARS-CoV-2 transmission in schools has been demonstrated with previous SARS-CoV-2 variants.

Added value of this study

-We used a quasi-experimental design to study the effectiveness of the FCM mandate, comparing the outcome between children with mandatory use of FCM and children without.

-The differences in terms of incidence, SAR or R* between children in the final year of preschool and children in the 1st year of Primary education were not statistically significant, therefore making FCM mandatory is not effective.

-Age-dependency is key for understanding SARS-CoV-2 transmission with the Delta variant, reinforcing the same outcome that was observed with previous SARS-CoV-2 variants.

Implications of all available evidence

-The effectiveness of the FCM mandate for children attending school is based on insufficient scientific evidence.

-The immunological innate host response in younger children that wanes as they get older, alongside classroom dynamics, could explain the age-dependency gradient in the incidence, SAR and R* results of the study.

Background

Experimental studies have clearly established the efficacy of masks in preventing the release and inhalation of different particles, showing large reductions in emissions which range from 50% to 90% depending on the type of mask.[1–6] Furthermore, some observational studies have shown that the use of masks can be effective in reducing the transmission of respiratory viruses in certain conditions or settings, although the real-life reductions have often been lower than those shown in the laboratory studies.[7–10]

In this context, the mandatory use of face covering masks (FCM) has been a part of public health policy in many countries, as one of the non-pharmaceutical interventions (NPI) aimed at preventing the transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) during the 2019 coronavirus disease (COVID-19) pandemic. In addition, some countries implemented FCM mandates in schools despite the fact that the European Centre for Disease Prevention and Control and also the World Health Organisation only recommended their use for children over 12, or in situations where community transmission is high.[11,12] Several factors can affect the ability of masks to reduce transmission, for example the percentage of susceptible population, the type of setting and the level of compliance. Specifically, in schools, the effectiveness of the mandatory use of FCM is a matter for debate. In general, COVID-19 is less severe in children, who typically present milder symptoms than adults, or no symptoms at all. There is evidence that age-related factors in innate and adaptive immune response, off-target effects of vaccines, cross-reactive immune responses to seasonal coronaviruses, and clotting and endothelial function can contribute to differences in the severity of COVID-19 observed between children and adults.[13–19] Up-to-date studies in educational settings point in both directions when it comes to the effectiveness of FCM mandates: a compulsory FCM policy in schools may have had either no effect, a minor effect or a more pronounced effect.[20,21] Some of these studies have used an ecological design, and their findings may have been affected by various limitations and confounders. It is thus clear that randomised controlled trials (RCT)

would be ideal to elucidate the effectiveness of such policies, although they are difficult to perform in schools.

In Catalonia, an autonomous region in north-eastern Spain with a population of 7·6 million, schools reopened in September 2020 for face-to-face tuition with some NPI in place. This included bubble groups, groups comprising a fixed and stable number of students and teachers that behave in a homogeneous way, a measure used to facilitate traceability, identify the need for self-isolation, and reduce transmission. Hygiene measures were also introduced, as well as daily screening for symptoms, a 10-day quarantine period, and testing for all the students within a bubble group in the case of a confirmed infection within that group, together with the mandatory wearing of FCM for children over five.[22] A study performed during the first term of the 2020-2021 academic year showed an age-dependency on SARS-CoV-2 transmission in schools with no significant differences between children under six (where there was no mandatory use of masks) and older children.[23] At the beginning of the first trimester of 2021-2022, Delta was the most prevalent variant, vaccination coverage was 92% for teachers, 80·4% for students over 12, and the vaccination programme for children under 12 had not yet begun,[24] while FCM mandates and other NPI remained. In the absence of RCT on the topic, this situation allowed us to perform a quasi-experimental study for analysing the effectiveness of FCM mandates.

We analysed routinely collected health data to compare the incidence of SARS-CoV-2 secondary attack rates (SAR) and the effective reproductive number (R*) among school children aged between three and eleven, comparing those without mandatory FCM in preschool stage (3 -5 year olds) and primary school children where the use of masks is indeed mandatory (6-11 year olds) during the first trimester of the school year 2021-2022 (13 September 2021-22 December 2021).

Methods

Study design and data sources

A retrospective population-based cohort study was designed. Data were obtained from the official census of school age children in Catalonia linked to the regional central database of reverse transcriptase polymerase chain reaction (RT-PCR) and lateral flow tests (LFT) for SARS-CoV-2. During the study period, each time a positive case was detected by the health system, the whole bubble group was immediately quarantined for a 10-day period, and all children in the group were tested with an RT-PCR four to six days after their last contact with the person infected, with a recommendation that a second test should be performed if symptoms should appear despite a negative test result.

Participants, cohorts, and follow-up

The study population was a cohort of children aged between three and eleven assigned to a stable bubble group according to the 2021-2022 academic census from the Catalan Department of Education. As the school census allows the declaration of bubble groups of any size, we excluded those with either more than 30 or less than 5 members, to ensure better intra-group stability. We also excluded schools that did not have bubble groups for all 9 academic years.

We used data from the first trimester of the 2021-2022 academic year, from 13 September 2021 to 22 December 2021 for the purposes of recruiting, and allowed for 10 more days (until January 1, 2022) for the occurrence of possible secondary cases for SAR and R* calculations with the same follow-up period for all index cases.

We defined an index case as the first case in a bubble group in a 10-day window, and secondary cases were defined, according to Catalan SARS-CoV-2 management guidelines, as any case where there was a positive test within the 10 days following an index case in their

bubble group. A student testing positive after this 10-day period was considered as a new index case.

Analyses were performed at bubble group and academic year levels. Groups were analysed by school year, three in preschool stage (P3, P4 and P5 according to the age of the students in each year group) and six in primary education stage (years 1 to 6, ages six to eleven years).

We performed a subgroup analysis between children at P5 year and children at 1st year of primary education. The only difference between them, regarding NPI, is the FCM mandate: children aged five years without the mandatory use of FCM (P5 year) and children aged six years with mandatory use of FCM (Primary education 1st year).

Study outcomes and epidemiological measures

The primary outcome was SARS-CoV-2 infection, defined by the date of the first positive RT-PCR or LFT, regardless of the presence of any symptom or clinical diagnosis.

For each school year, we calculated three epidemiological variables:

- Incidence of SARS-CoV-2 infection: as the number of children with a positive test divided by the population.
- SAR: the number of new cases in a bubble group divided by the total number of at-risk group members after subtracting the index case. SAR was calculated for each bubble group, and then summarised for each school year as the mean and the median.
- R*: the average number of secondary cases for each index case as described elsewhere.[23] The average R* was calculated for all bubble groups within each school year.

Statistical analysis

For descriptive analysis, we expressed continuous variables as mean (standard deviation) or median (interquartile range, IQR) and summarised categorical variables as number (percentage). We calculated a 95% confidence interval (95%CI) for incidence of SARS-CoV-2 infection and SAR. We used a logistic regression model to estimate the odds ratio (OR) and 95%CI of SARS-CoV-2 incidences and a negative binomial model to estimate the incidence risk ratio (IRR) and 95%CI of SAR between the P5 school year, and the first year of primary education stage. From the distribution of cases, we fitted a negative binomial distribution to obtain the mean (R*) and the 95%CI from the standard deviation. We used R version 4.0.0 and MATLAB 2021b for the analyses.

Results

A total of 1,907 schools, 28,575 bubble groups and 599,314 (94·7%) of pupils were included in the analysis after the exclusions. **Figure 1** shows the flow-chart for the population that is the subject of the study.

The number of SARS-CoV-2 infections during the study period was 24,762 (4·13%). **Table 1** summarises the number of students, bubble groups and SARS-CoV-2 infections for each school year. **Figure 2** shows the 7-day moving average of SARS-CoV-2 infections during the school trimester by school year. We observe that all school years follow a similar pattern, and preschool years were consistently less infected than older children. Incidence was lower in preschool stage than in primary education, ranging between 1·74% in P3 and 5·91% in year 6 of primary education, showing an age-dependency trend (**Table 2**).

We analysed 13,404 outbreaks during the study period. On average, 57% of outbreaks had no secondary cases, but there were more outbreaks without secondary cases in preschool (70%) than in primary education (53%) (**Table 1**). Median SAR was 0 in all years except for year 6 of primary education (**Table 2**). **Figure 3** shows the mean SAR by school year. While lower values

were observed in preschool (2·34%, 2·77% and 4·59% in P3, P4 and P5, respectively) the highest values were in year 6 of primary education, with a mean SAR of 7·17%. The same pattern was observed for R*, highlighting the low values in preschool P3 and P4 and the R*>1 for years 3, 4, 5 and 6 of primary education (**Figure 3**).

<u>P5 versus year 1 of primary education subgroup analysis</u>

The incidence of SARS-CoV-2 and the percentage of positive tests were significantly higher for year 1 of primary education than in P5: incidence was 3·54% vs 3·1%, with an OR of 1·15 (95%CI: 1·08-1·22); and test positivity was 7·98% (95%CI: 7·69%– 8·27%) and 6·82% (95%CI: 6·55%–7·10%), respectively. Conversely, SAR and R* were similar for both years. Median SAR was 0, and mean SAR was slightly lower - but not statistically significant - in year 1 of primary education than in P5, 4·36% vs 4·59% respectively (IRR: 0·96 [95%CI: 0·82–1·11]). Furthermore, R* was not significantly lower for year 1 of primary education either: 0·90 vs 0·93 (OR: 0·96 [95%CI: 0·87–1·09]) (see **Table 2** and **Figure 3**). Finally, the percentage of outbreaks without secondary cases was higher in P5 (64·2%) than in year 1 of primary education (61·3%).

Discussion

The main findings of the study show no significant differences between P5 and year 1 of primary education in terms of transmission indicators during the first trimester of the current academic year, despite the difference in the FCM mandate, and a strong age-dependency in the transmission of SARS-CoV-2 in the schools, reinforcing the results published for the year 2020-2021, but with a different and more transmissible SARS-CoV-2 Delta variant.[23]

The age-dependency trend observed for P5 (preschool) and older children follows a different pattern when P3 and P4 are included in the analysis. With no mandatory use of FCM, the youngest children have significantly lower transmission indicators when compared with any other year group. These findings may be related to the age decrease trend of the innate immunological response, and a shift towards an adult-like immunological response pattern as

the child enters primary school as had already been observed in a study of immune response following a SARS-CoV-2 infection. The changes in the innate immune cell populations for children under five showed significantly lower proportions of circulating monocytes and dendritic cells compared to SARS-CoV-2 positive children over the age of five.[13] The authors concluded that innate immune differences between infected children and infected adults were most evident in infants and preschool age children.[13] Moreover, another study on the role of the neutralising antibodies in the adaptive immune response against SARS-CoV-2 mild infections showed that their titers were inversely correlated with age and children under six, and in particular toddlers under three years of age had the highest values throughout early, intermediate and late follow-up endpoints since infection onset.[17] Finally, as primary infection with several human coronaviruses typically occurs early in childhood, and children are frequently reinfected with common cold coronaviruses, finding more cross-reactive T cells in younger children than in adults or those at advanced stages of childhood is to be expected.[18,25]

Despite no significant differences between P5 and the first year of primary education being found in transmission indicators, the observed SAR and the R* values suggest that P5 could have transmission values slightly higher than those expected when extrapolating the age-dependency of older children down to those of preschool age. On the contrary, P3 and P4 data suggest lower values than expected. Looking at years 1 to 6 of primary education, (i.e. six to eleven year olds), the variation of incidence, SAR and R* with age suggests a linear relationship. A linear regression to these data provides an r^2 of 0·99 (incidence-age), 0·95 (SAR-age) and 0·96 (R*-age). If we extrapolate a backward regression to P5, we notice that the observed values of both SAR and R* are 18% higher than those expected from the regression model for children in primary education, while the incidence remains 2% below the expected value. On the other hand, P3 and P4 show mean SAR values that are 19% (P3) and 18% (P4) lower than those expected from this extrapolation of the primary education regression model. The observed R* values would be 24% (P3) and 20% (P4) lower than those expected, and the

incidences would be 21% (P3) and 14% (P4) below the expected values (see supplementary figures S1, S2 and S3).

The difference in P5 between observed and expected SAR an R* could be explained by different FCM mandates in preschool and primary education, but other reasons may also come into play. For instance, it can be influenced by the differing classroom dynamics in preschool and primary education, which involve closer contact between children at younger ages. Furthermore, test positivity was statistically lower in P5, suggesting greater efforts being made in testing in the case of younger children. Even in the best case scenario for FCM mandates, and assuming that all the differences between observed and expected R* and SAR were related to FCM use (a highly implausible assumption), the implementation of this measure could have avoided a statistically non-significant number of secondary cases of 162 (95% CI: -28–352) in a population of 63,344 students during the whole of the period covered by the study (0·3%, i.e., the cumulative incidence could have been 2·8% rather than 3·1%), pointing to a limited or marginal effect of the FCM mandates in schools.

These values are much lower than those found in some studies. The odds of an outbreak occurring were 3·5 higher in those primary and secondary schools (K-12) without an early mask mandate in two Arizona counties during 15 July – 31 August 2021.[26] By analysing 520 counties during the first two months of the 2021-2022 academic year in the USA, it was found that those counties without an FCM mandate presented greater increases in paediatric SARS-CoV-2 cases.[20] However, these studies have certain limitations: they are ecological studies which do not make a distinction between children and adolescents in their analyses, or take differences in staff vaccination status or testing rate into account. It should be noted that substantial reductions in transmission have only consistently been detected in laboratory settings and in tightly controlled environments,[4,9,10] and would imply extremely high compliance in terms of the wearing of properly fittings masks, and of use of masks that offer the highest level of protection (FFP2) which, at least in Spain, are not in frequent use in any educational setting.

However, the results obtained from our work show results similar to those obtained in other studies that analyse the impact of mask-wearing policies for students in educational settings. No correlation between mask mandates at district level and SARS-CoV-2 rates were found in Florida (USA) schools during the 2020-2021 academic year.[27] Similarly, by comparing 123 UK secondary schools with FCM mandates with 1,192 where such mandates were not imposed over the course of three weeks during the 2021-2022 academic year, the absence rate due to COVID-19 decreased 0·6% (11% relative difference) in the former group, although this was found to be statistically non-significant using entropy balancing.[28]

Our study has certain limitations. We performed an intention-to-treat analysis. This means that there may have been children in P5 who did use FCM, and also children in year 1 of primary education who did not, or who used it incorrectly. However, the aim of our study was not to measure the individual effectiveness of the use of FCM, but to evaluate the effectiveness of mask mandates in schools, in the way that these have been implemented in the real-world. Although both cohorts were balanced at territorial and socioeconomic levels given the study design, there may be other variables that were not considered (i.e., classroom dynamics or the density of students in the classroom). Besides, we are probably overreporting the study outcomes because we were working on the assumption that all the secondary cases stemmed from infection by an index case within the bubble group, and not through concomitant cases in a 10-day window or infection through an index case in the child's household. In fact, the home has presented the greatest risk of exposure since the beginning of the pandemic, both in Spain and elsewhere. Finally, a higher percentage of asymptomatic infections in younger children might produce an infra-detection of individual asymptomatic cases, but huge diagnostic efforts to detect these infections have been in place since the previous academic year 2020-2021.[29] In fact, if a non-detected asymptomatic individual should generate an outbreak of secondary infections, the chance of the infection being detected on subsequent contact screenings

increases. This points towards global transmission indicators that could be even lower than those observed in this study.

During the study period, Delta was the most prevalent SARS-CoV-2 variant. However, at the beginning of January 2022, Omicron became the dominant variant (>95% on January 5, 2022 according to Catalan authorities). This led to the highest rates of community SARS-CoV-2 transmission of the whole pandemic. At the beginning of the second trimester (January 10, 2022), 7-day cumulative COVID-19 per 100,000 inhabitants was 2391.6 (see official Catalan website about COVID-19: https://dadescovid.cat/?lang=eng). That could affect the odds to find a secondary case that in fact is a concomitant case. In addition, school guidelines changed for the second trimester of the academic year 2021-2022. First, children in school only have to be isolated if more than 4 cases have been detected in a 7-day window. Second, quarantines of close contacts and isolation of cases have been reduced from 10 days in the first trimester to 7 days in the second. Third, school guidelines before 2022 recommended performing a PCR for screening of contacts inside a bubble group while during the second trimester the test used was a LFT. Finally, the vaccination campaign for children between 5 and 11 years was launched at the end of December. Data from the second trimester is thus not comparable to the data analysed in our article. Nevertheless, it is unlikely that the effectiveness of the mask mandate measure will increase with a more transmissible variant.

This study also has certain strengths. We analysed two homogenous cohorts (P5 and year 1 primary education), the latter with mandatory use of FCM, acting as an interventional group, and the former without, as a control group. We do not expect to find great differences in the host response due to the age or in the behaviour between both grades that could influence the results obtained, although it should be considered that classroom dynamics may be different. Given the difficulty of conducting RCT in educational settings, we believe that this quasi-experimental analysis is the best possible approach to the aim of the study. In addition, the analysis of the rest of the years of primary education clearly shows an age-dependency

increase trend for all the epidemiological measures, suggesting that the age variable is the most important component. This is consistent with the findings of a study performed with data from the first trimester of the previous academic year and different SARS-CoV-2 variant,[23] where it was observed that transmission in educational settings increased with age independently of the use of FCM.

In conclusion, FCM mandates in schools were not associated to a lower SARS-CoV-2 incidence, SAR or R*. Conversely, we found lower incidence and transmission in younger children (without FCM mandates in school), suggesting that age is the most important component to explain transmission in children.

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Ethics statement

The study was evaluated and approved by the Clinical Research Ethics Committee of the IDIAP Jordi Gol, Reference 21/018-PCV. This research was based on the agreement established in Regulation 2016/679 of the European Parliament and the Council of Europe of 27 April 2016 on Data Protection, and Organic Law 3/2018 of December 5 on the protection of personal data and the guarantee of digital rights.

Data sharing statement

All data in this study will be shared on reasonable request to the corresponding author.

Declaration of interests

The authors declare that they have no conflict of interests.

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Table 1. Number of students, bubble groups and SARS-CoV-2 infections by grade.

Year	Mean age (SD)	Students	Bubble groups	Cases from September 13 to December 22, 2021	Index Cases (outbreaks)	Secondary cases	% of outbreaks without secondary cases
P3	3·1 (0·3)	54 210	2 932	942	724	307	75·3
P4	4·0 (0·2)	60 094	2 994	1 388	976	526	72·7
P5	5·0 (0·3)	63 344	3 040	1 966	1 133	1 052	64·2
1	6·0 (0·2)	66 204	3 148	2 346	1 405	1 269	61·3
2	7·0 (0·2)	67 455	3 186	2 781	1 569	1 566	56·3
3	8·1 (0·3)	66 614	3 131	3 074	1 638	1 877	53·1
4	9·0 (0·3)	71 590	3 292	3 703	1 879	2 436	52·6
5	10·1 (0·3)	73 702	3 349	4 062	2 029	2 611	51·0
6	11·0 (0·3)	76 101	3 503	4 500	2 051	3 092	48·8
Preschool Education (P3-P5)		177 648	8 966	4 296	2 833	1 885	70·0
Primary Education (years 1-6)		421 666	19 609	20 466	10 571	12 851	53·3
Total		599 314	28 575	24 762	13 404	14 736	56·8

Table 2. SARS-CoV-2 incidence, secondary attack rate (SAR), effective reproductive number (R*) and percentage of positive tests by school year.

Year (Age)	SARS-CoV-2 incidence (95%CI)	SAR Mean (SD)	SAR Median (IQR)	R* (95%CI)	% of positive tests (95%CI)
P3 (3)	1·74% (1·63 – 1·85)	2·34% (5·53)	0·00 [0·00;0·00]	0·42 (0·35 – 0·49)	3·26 (3·06 – 3·45)
P4 (4)	2·31% (2·19 – 2·43)	2·77% (6·55)	0·00 [0·00;4·17]	0·54 (0·46 – 0·61)	4·89 (4·65 – 5·12)
P5 (5)	3·10% (2·97 – 3·23)	4·59% (9·30)	0·00 [0·00;5·00]	0·93 (0·82 – 1·04)	6·82 (6·55 – 7·10)
1 (6)	3·54% (3·40 – 3·68)	4·36% (8·38)	0·00 [0·00;5·00]	0·90 (0·81 – 0·99)	7·98 (7·69 – 8·27)
2 (7)	4·12% (3·97 – 4·27)	4·92% (8·95)	0·00 [0·00;5·88]	1·00 (0·91 – 1·08)	8·67 (8·38 – 8·96)
3 (8)	4·61% (4·45 – 4·77)	5·57% (9·52)	0·00 [0·00;7·62]	1·15 (1·05 – 1·24)	9·09 (8·80 – 9·37)
4 (9)	5·17% (5·01 – 5·33)	6·10% (9·76)	0·00 [0·00;8·33]	1·30 (1·20 – 1·39)	10·02 (9·74 – 10·31)
5 (10)	5·51% (5·35 – 5·67)	6·06% (9·86)	0·00 [0·00;8·33]	1·29 (1·20 – 1·38)	9·55 (9·29 – 9·81)
6 (11)	5·91% (5·74 – 6·08)	7·17% (11·8)	3·85 [0·00;9·09]	1·51 (1·40 – 1·61)	10·36 (10·09 – 10·63)

Figure 1. Population flow-chart

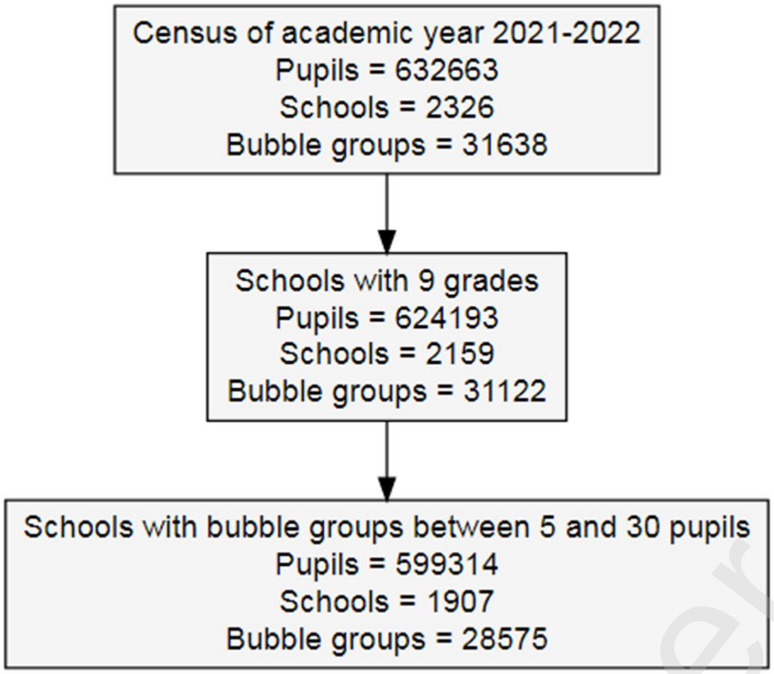


Figure 2. 7-day moving average of daily SARS-CoV-2 infection rates per 100,000 population by school year (P3-P5 for preschool, and years 1-6 for primary education)

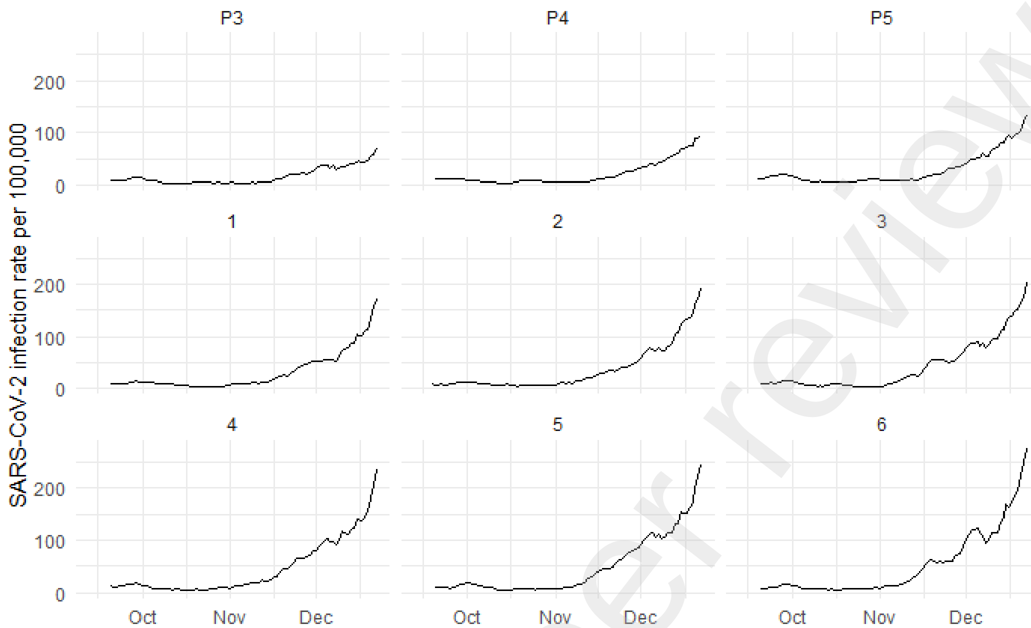
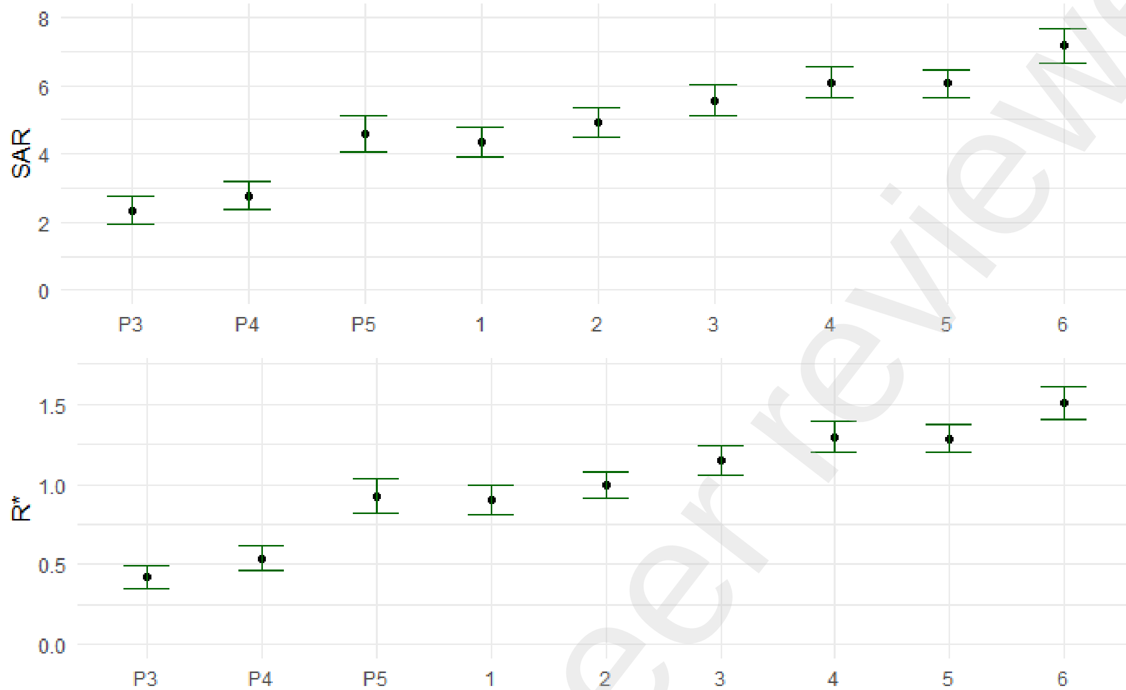


Figure 3. Median secondary attack rate (SAR) and effective reproductive number (R*) with 95%CI by school year (P3-P5 for preschool and years 1-6 for primary education).



Unravelling the role of the mandatory use of masks in the control of SARS-CoV-2 in schools: A quasi-experimental study nested in a population-based cohort in Catalonia (Spain)

Appendix

We fitted a linear regression to incidence (Figure S1, R^2 0.99), SAR (Figure S2, R^2 0.95) and R* (Figure S3, R^2 0.96) with age, using data from primary education pupils from 6 to 11 years of age. The fitting was performed using the *fitlm* function of MATLAB 2021b. The 95% CI was assessed using the *predict* function. This function was also used to extrapolate the model to preschool year groups.

Figure S1. Linear regression model of incidence with age. The regression model is fitted to data of primary school children (6 to 11 years of age). The grey area indicates the 95% CI of the fitting. Observed values are split between those that were used in the regression model (black dots, children in primary education) and those that were not (blue dots, preschool children).

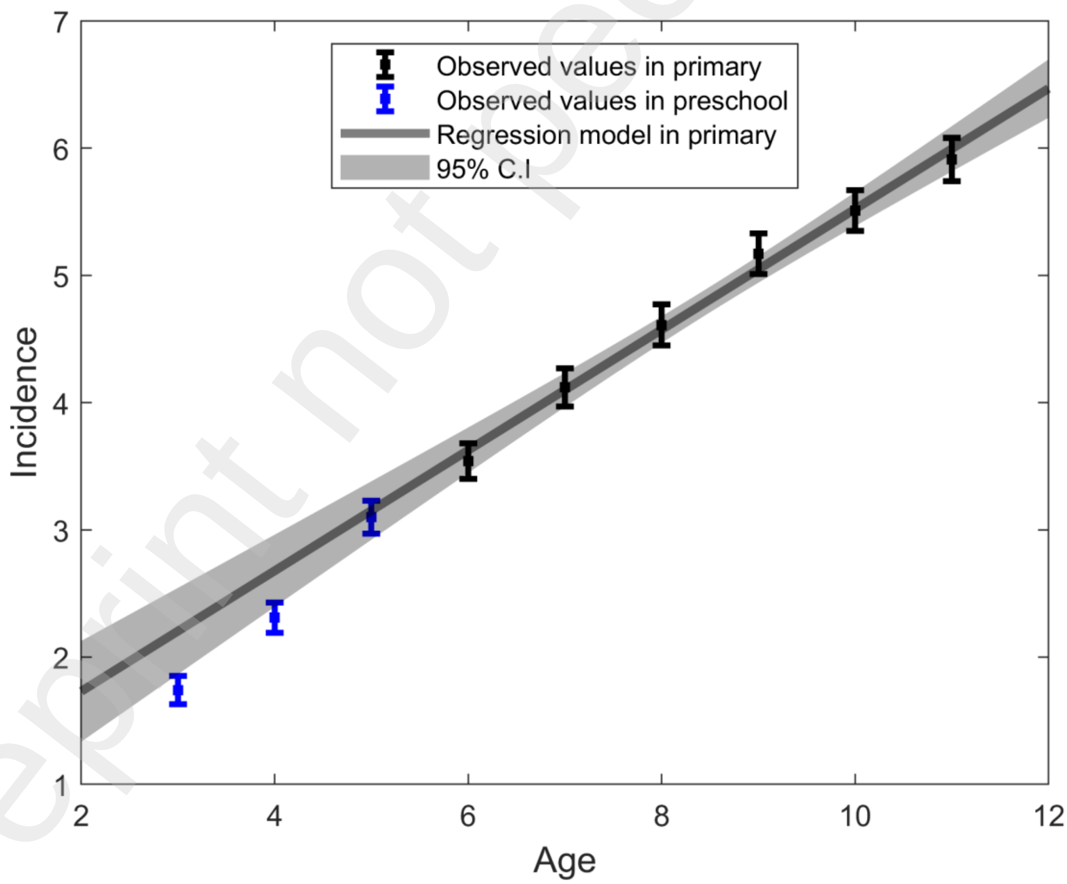


Figure S2. Linear regression model of secondary attack rate (SAR) with age. The regression model is fitted to primary education data (6 to 11 year olds). The grey area indicates the 95% CI of the fitting. Observed values are split between those that were used in the regression model (black dots, children in primary education) and those that were not (blue dots, preschool children).

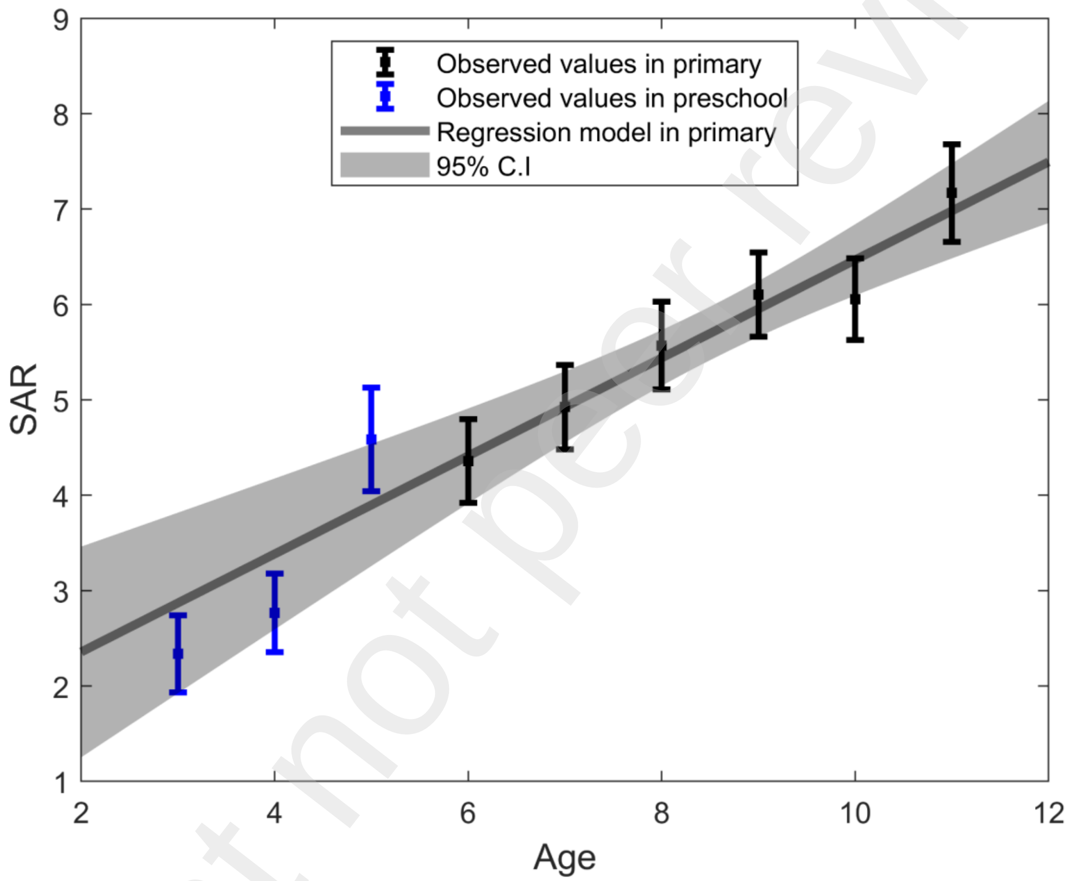


Figure S3. Linear regression model of effective reproduction number (R*) with age. The regression model is fitted to data of primary school children (6 to 11 years of age). The grey area indicates the 95% CI of the fitting. Observed values are split between those that were used in the regression model (black dots, children in primary education) and those that were not (blue dots, preschool children).